How to Assemble the 4x4x4 LED Cube
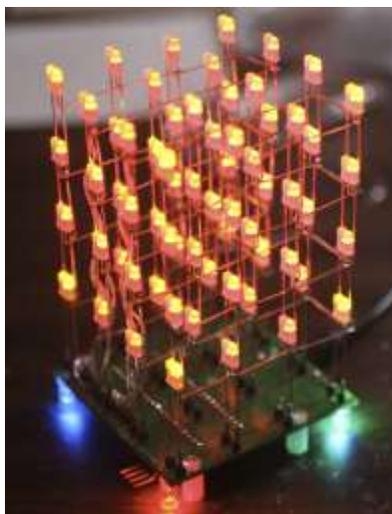
Kit from http://www.52dz-diy.com/

Instructions by Peter Brown KE5IOV & Beth Madry KE5IOU

Build tested by Sarah Brown KF5LFK

Version 1.1

December 16, 2017

FERNSOFT

Email: kits@fernsoft.com

Table of Contents

1. Unpack and sort components

Figure 1 - Kit Contents

Disclaimer: We are creating these instructions for the good of the community and have no connection with the creators of this kit. We have no control over the version or contents of this kit. If these instructions do not seem to match your kit please stop following these instructions and seek further information. Best of luck, 73s.

Your kit should contain the following:

Table 1 - Parts List

| Designation	Description	Qty
	Circuit Board	1
U1	Processor IC STC-15W1K16S	1
	Processor Socket	1
C1,C12	Ceramic capacitors 0.1uF (104)	2
C2	Electrolytic capacitor 220uF	1
R1	10K resistor (brown-black-orange)	1
R2,R3	470 ohm resistor (yellow-violet-brown)	2
5VDC	Power socket	1
Q1	S8550 PNP Transistor	1
BELL	Speaker	1
HS0038	Universal IR Receiver	1
	Bi-Color Rectangular LED	64
LED1-LED4	LED Flashers	4
	Hookup Wire	1
Power	SPDT Switch	1
	Standoff and screws	4
	Header pins	40
UART	Right Angle 4 pin header	1
	5V USB power supply	1
	USB Cable	1
	Remote Control	1

2. Theory of operation
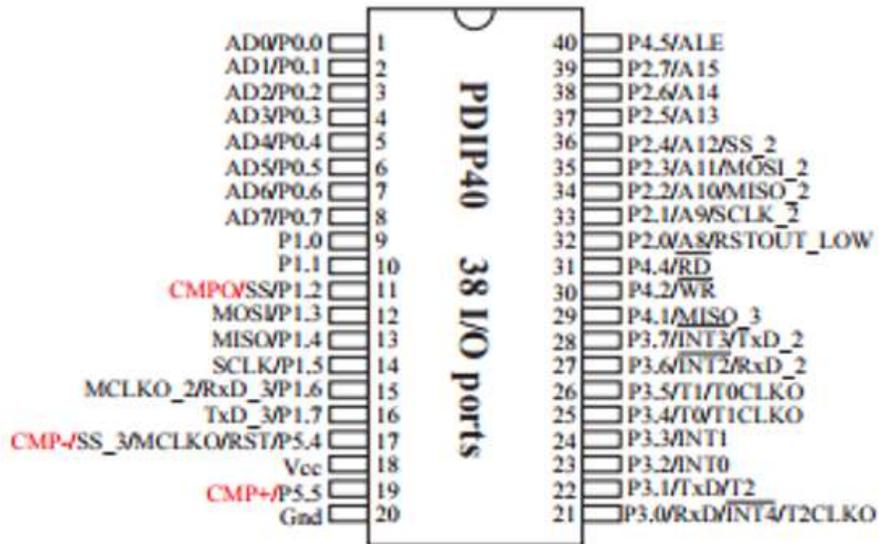
Figure 2 - STC15W processor
(http://www.stcmicro.com/datasheet/STC15W1K16S_Features.pdf)

The STC15W1K16S is an 8 bit processor based on the 8051, an ancient workhorse part that has been around since the early 1980s. This part acts as an all in one computer with embedded flash memory and embedded RAM. The processor in the kit is preprogrammed with a clever program that flashes the LED cube in creative patterns. It does this by controlling the General Purpose Input / Output (GPIO) pins using a multiplexing method called CharliePlexing that allows the chip to handle more LEDs than it has GPIO pins.
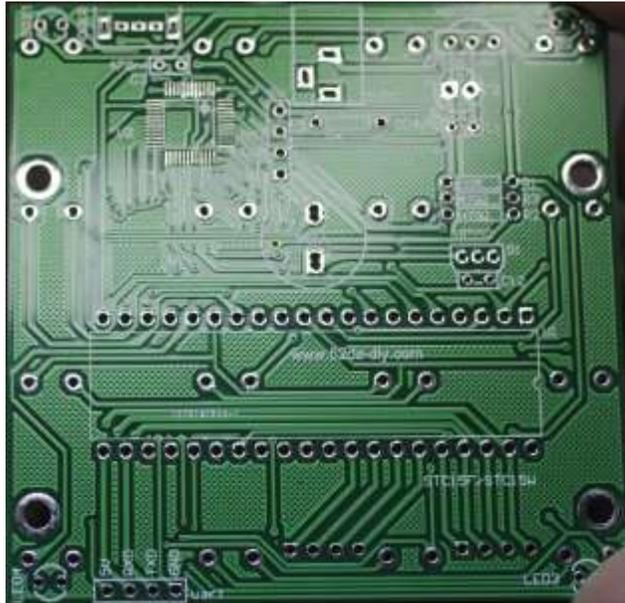
3. Beginning Construction - Header Pins

Figure 3- Component Side of Board

The circuit board has a component side upon which most of the components are inserted, and an LED side on which the LED cube will be built. When the cube is complete, the component side will face down, and the LED side will face up. The component side can be identified by finding the side of the board with the silkscreen outlines of the various components (see Figure 3).

Note: the header pins in this step are inserted into the LED side of the board, NOT the component side of the board that has all of the silk screened outlines. Separate the header pins to fit in the holes. First break off two sets of 4 pins, then break off the remaining 32 pins singly. Header pins are inserted by placing the short end into the circuit board. From the LED side of the board insert the 4 pin headers into P1 (P20-P23) and P2 (P24-P27). The best way to get these headers straight is to solder only one pin on each, then flip the board over and check the header. Reflow the solder and straighten the header if necessary. Once this is complete, flip the board back to the component side and solder the remaining 3 pins on each of these headers.
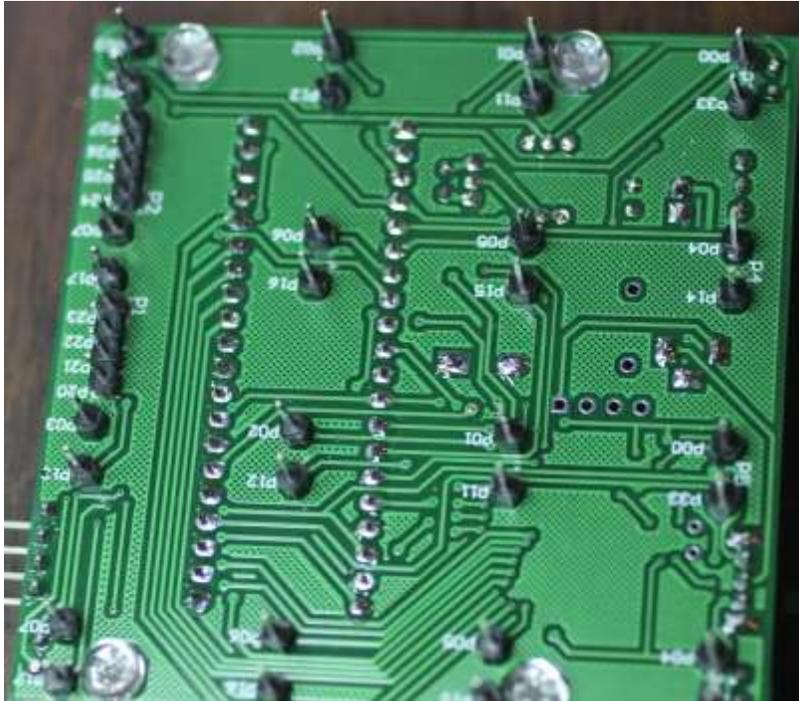
Figure 4 - Header Pins

Next insert the single pins into all 32 of the Pxx locations. There are two methods to do this, you can insert and solder each pin one at a time, or you can insert all of the pins at once and use a piece of anti-static foam, cardboard or perfboard to hold the pins in place when you turn the board over to solder. It is important that the pins end up straight. Carefully examine the pins and reflow the solder on any pin that is crooked, while straightening it. It is very important that these pins end up being straight and vertical because they will be the base of the LED tower that is to be built (see Figure 12).

4. Continuing Construction – Main Components

Reposition the board to the component side. It is the side with all of the component designations silk screened onto the board.   Insert the microprocessor socket into the microprocessor location U1. Align the socket so that the semicircular cut out matches the silk screen. Solder this in place.
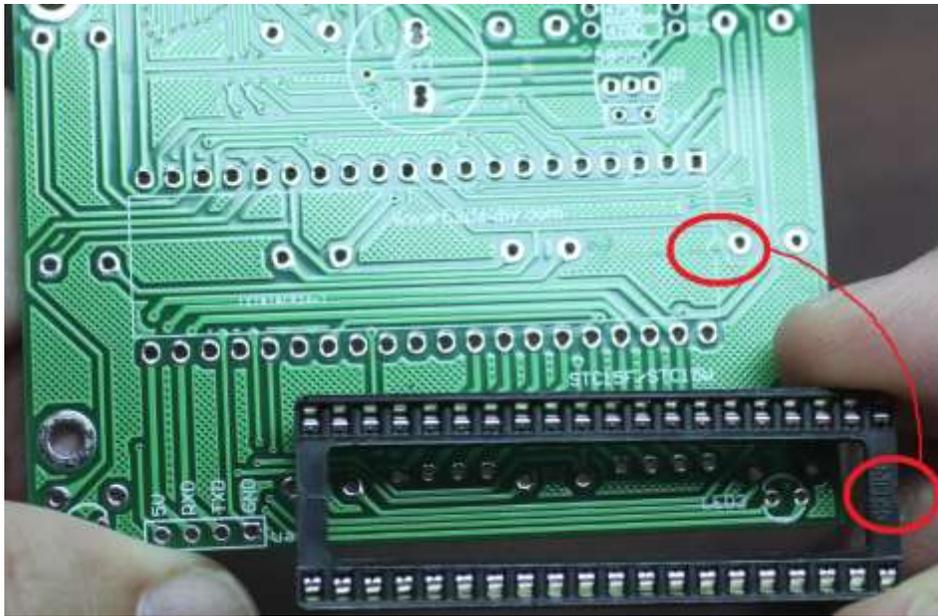
Figure 5- Microprocessor socket showing notch location

From the component side of the circuit board insert and solder into place each of the following components:

R1 – 10K ohm resistor is Brown Black Orange into R1 on the board

R2 & R3 – both 470 ohm resistors Yellow Violet Brown into R2 & R3

C1 & C12 – with 0.1 micro farad capacitor labelled 104

Q1 – follow the outline of the transistor

C2 – 220 micro farad capacitor. Take care to observe and match up polarity.

Figure 6- IR receiver

The IR receiver looks like an oversized bipolar transistor. It is black and very shiny and has three leads. Insert the IR receiver into the spot labeled HS0038 matching the component to the outline on the board. Solder into place.

Insert the 5Volt DC power jack into the spot labeled 5VDC, it can only be inserted in one orientation on the component side. Solder into place.

Insert the power switch into the location labeled POWER and solder it.

Insert the 4 LED flashers into the corners of the board (LED1-4). Each LED has a flat side, which is also denoted by the shorter of the two leads. Match these up with the flat side of the LED silkscreen. Insert and solder these LEDs. NOTE: these LEDs are optional, and although they do provide an interesting addition to the light show, they may detract from the main cube.
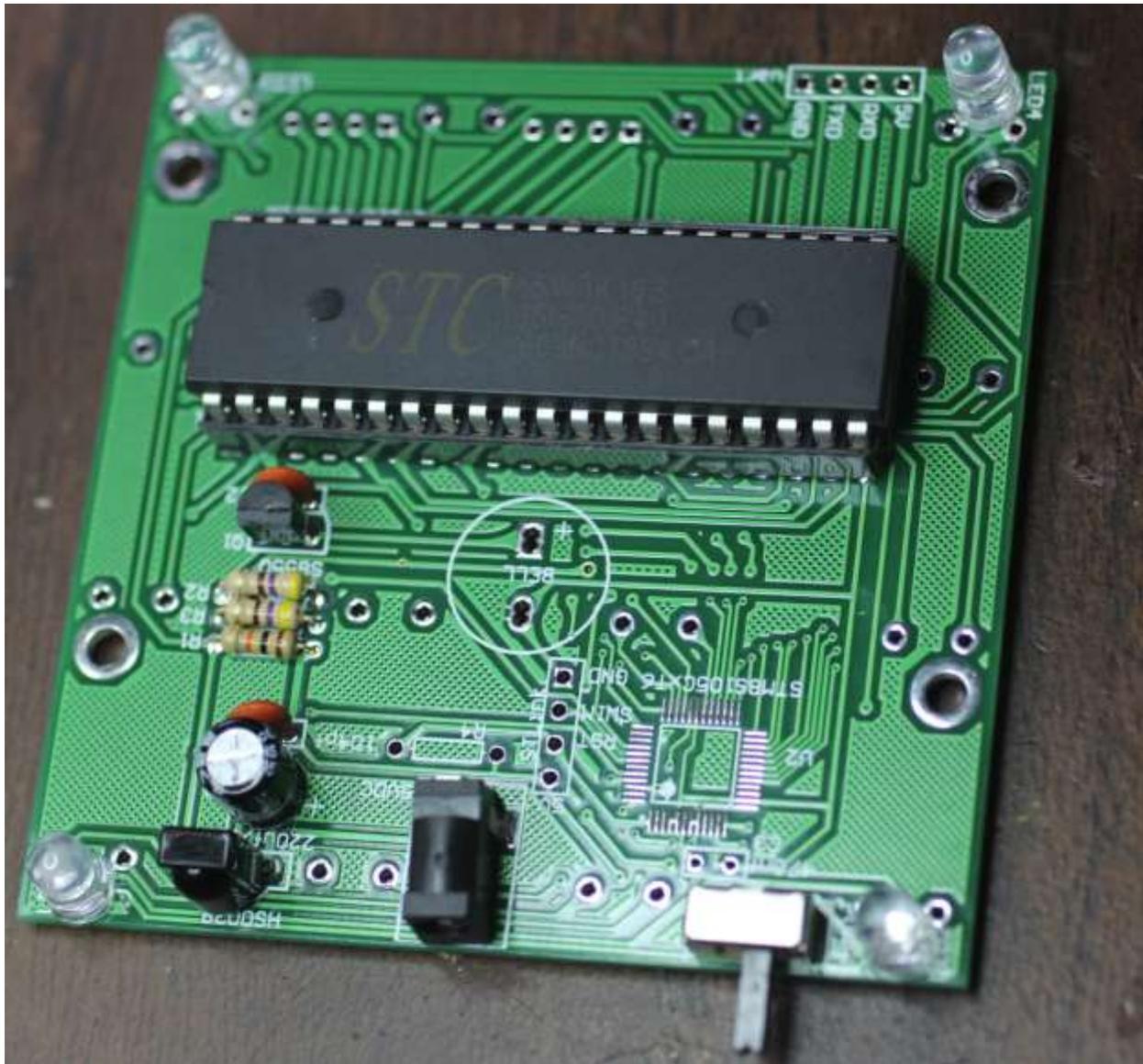
Figure 7 - Main components installed

At this point, the microprocessor can be inserted into the socket. This allows the LEDs to be tested. Care must be taken when inserting the microprocessor not to misalign any of the pins, mangling them during insertion. The best approach is to place the microprocessor horizontally on the table and carefully pre-bend the pins until they are closer to vertical. Make sure that the notched end of the microprocessor is oriented with the notched end of the socket and the notched mark on the silkscreen. Once the microprocessor is installed, connect the board to a 5 volt USB power source and if all is correct, the 4 LEDs should begin to flash. Disconnect power and continue construction.

Figure 8 - Annoying speaker that should not be installed

NOTE: do not install the speaker, you will be sorry, it is very loud and annoying. Insert the speaker into the spot labeled BELL observing polarity as labelled on buzzer and board, solder. **Once again it is strongly suggested to add a volume control or omit this part as the music it generates is extremely loud and annoying!**

Install and solder the UART connector. If you do not plan to use the UART, this step may be omitted.


Figure 9 - Nylon standoffs

The final step of the main board construction is to add nylon standoffs which act as feet. Since the component side of the board will be down facing in the final product, add the standoffs to that side, and screw into them from the LED side of the board as shown above.

5. Construction of LED Cube – Layer 1

Figure 10 - One of 64 LEDs for cube construction

Red
1

2

3
Green

1 Anode Red
2 Common Cathode
3 Anode Green
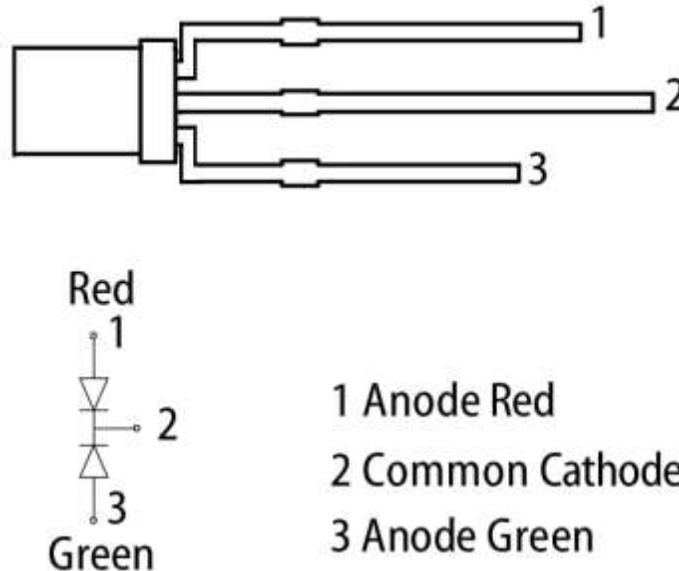
The LEDs used to build the LED cube are bi-color red-green LEDs composed of two separate LEDs housed in one package. Carefully examine one of these LEDs. Notice that the three leads are differing lengths. The center pin is the common cathode connected to both red and green LEDs, while the two other pins are the anodes. The shorter of the two leads connected to the green LED, while the longer connects to the red LED. **While building the cube it is very important that all of the LEDs are oriented the same way during construction. Otherwise the red and green colors will not be consistent.** Also notice on the leads that there is a place where the lead flanges out somewhat. This point is a useful guide on where to bend the center lead in the next step.
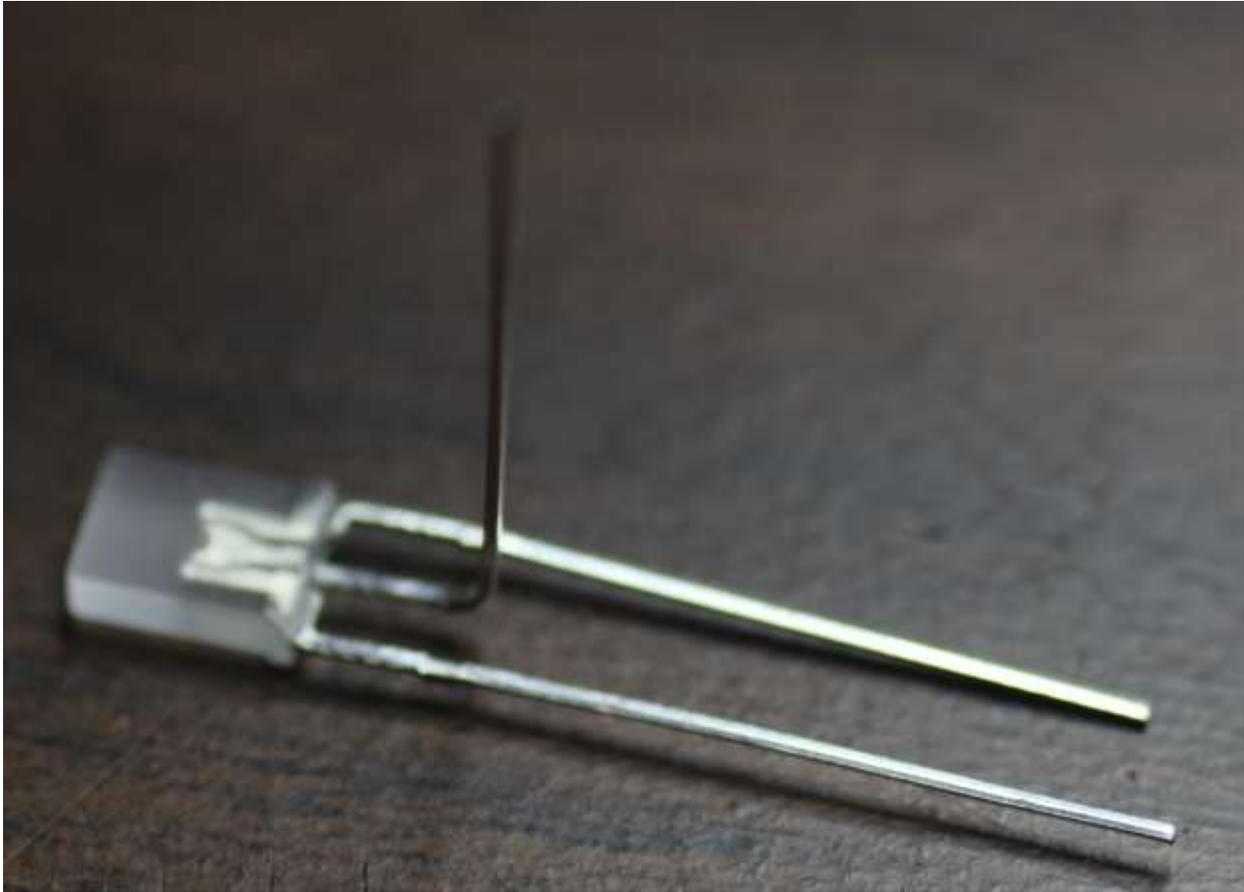
Figure 11 - Preparing LED for layer 1

Bend the center lead of the LED a bit less than 1 cm from the LED body, right at the point where the lead flanges slightly. Notice in the picture the orientation of the longer and shorter LED leads. Pre-tin the two unbent leads. Also, pre-tin all of the headers sticking up from the board. Now starting at location P07/P17 solder the LED to the two pins. Now prepare 3 more LEDs as above, and solder them at P06/P16, P05/P15 and P04/P14. The center pins of each LED now should also be daisy chained together by bending a slight hook in the end of each LED and soldering it to the next one in line (see Figure 16). Repeat this procedure for the next 4 LEDs at locations P03/P13, P02/P12, P01/P11 and P00/P33. You will now be left with two middle pins sticking out. Bend them at 90 degree angles toward each other taking can to not let them short out to the other pins of the LEDs. Needle noised pliers are a good tool choice for this task. Solder these two leads together. When complete, it should look like Figure 12. Now using a short piece of hookup wire, connect the center LED from the LED at location P03/P13 to the pin at location P20. See Figure 13. You may now test this section of the cube by connecting the 5VDC power supply and turning on the power switch. If your work is correct you should see a variety of patterns displayed on these 8 LEDs. Disconnect power and complete the bottom layer by adding LEDs at the other 8 locations. Connect the center lead from the LED at location P07/P17 to the header pin at location P24. Test this addition. This completes layer 1.
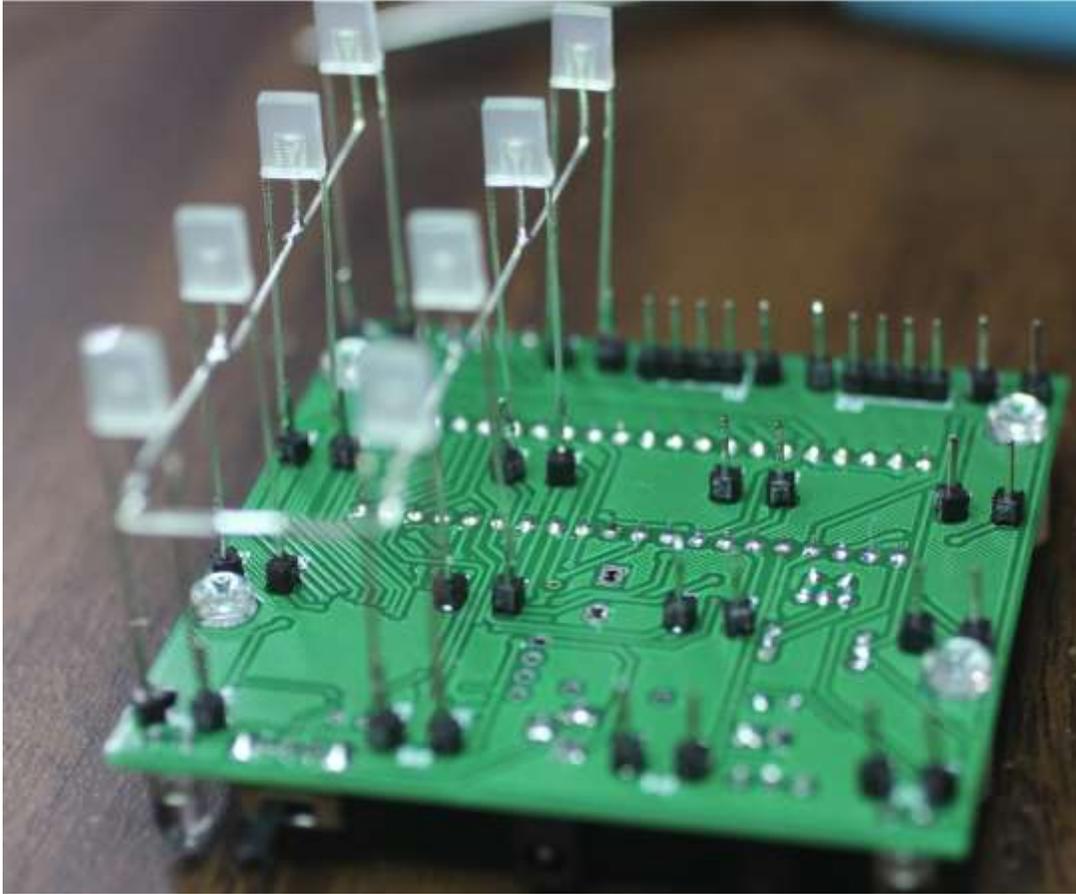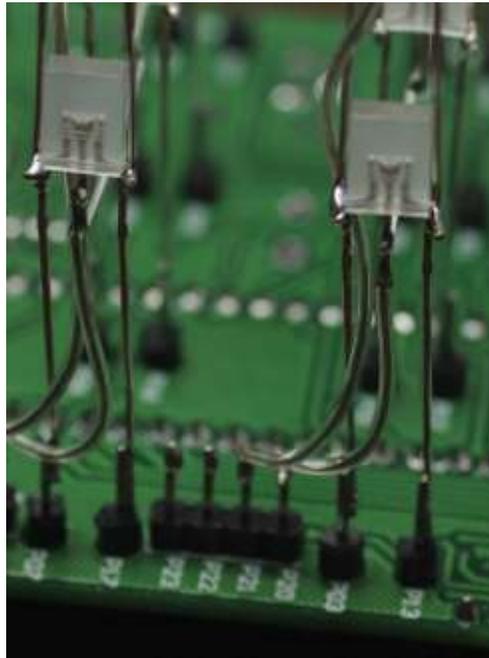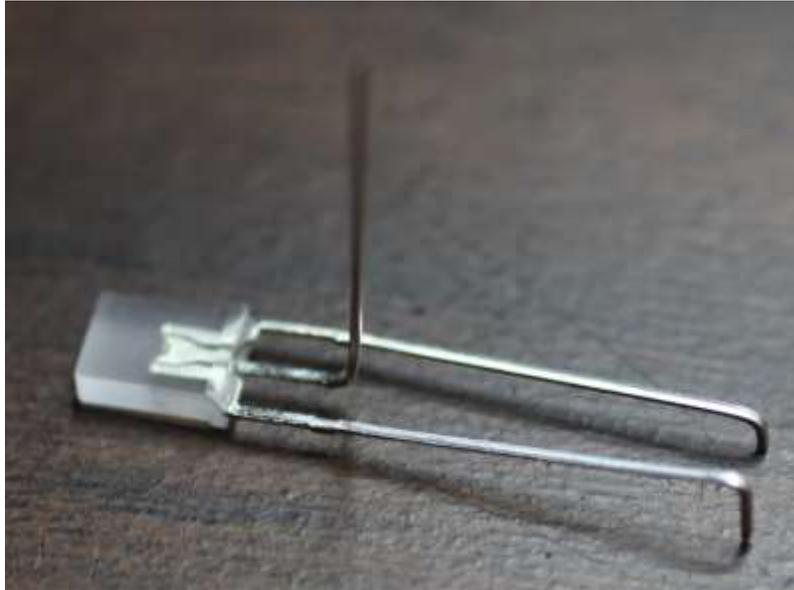
Figure 12 - First 8 LEDs

Figure 13 - Connection of center leads

6. Construction of the LED Cube – Layers 2-4

The next three layers are built in almost the same fashion as layer 1. The only difference is that it helps to solder the LEDs if a slight hook is bent in the ends of the outside leads. See Figure 14.

Figure 14 - Preparation of LED for upper layers

Once again, pay attention to keep the LEDs all oriented the same way. Now start the construction of later 2 by soldering the LEDs to the LEDs of layer 1 (see Figure 15). Build the first 8 LEDs and hook the middle pin daisy chain to P21. Test to make sure that all LEDs light. Complete layer two and hook the center pin to P25. This completes layer 2. Now build layers 3 and 4 following the same pattern. Care should be taken to ensure that the LED towers are as straight as possible, and that the LEDs end up at the same height.
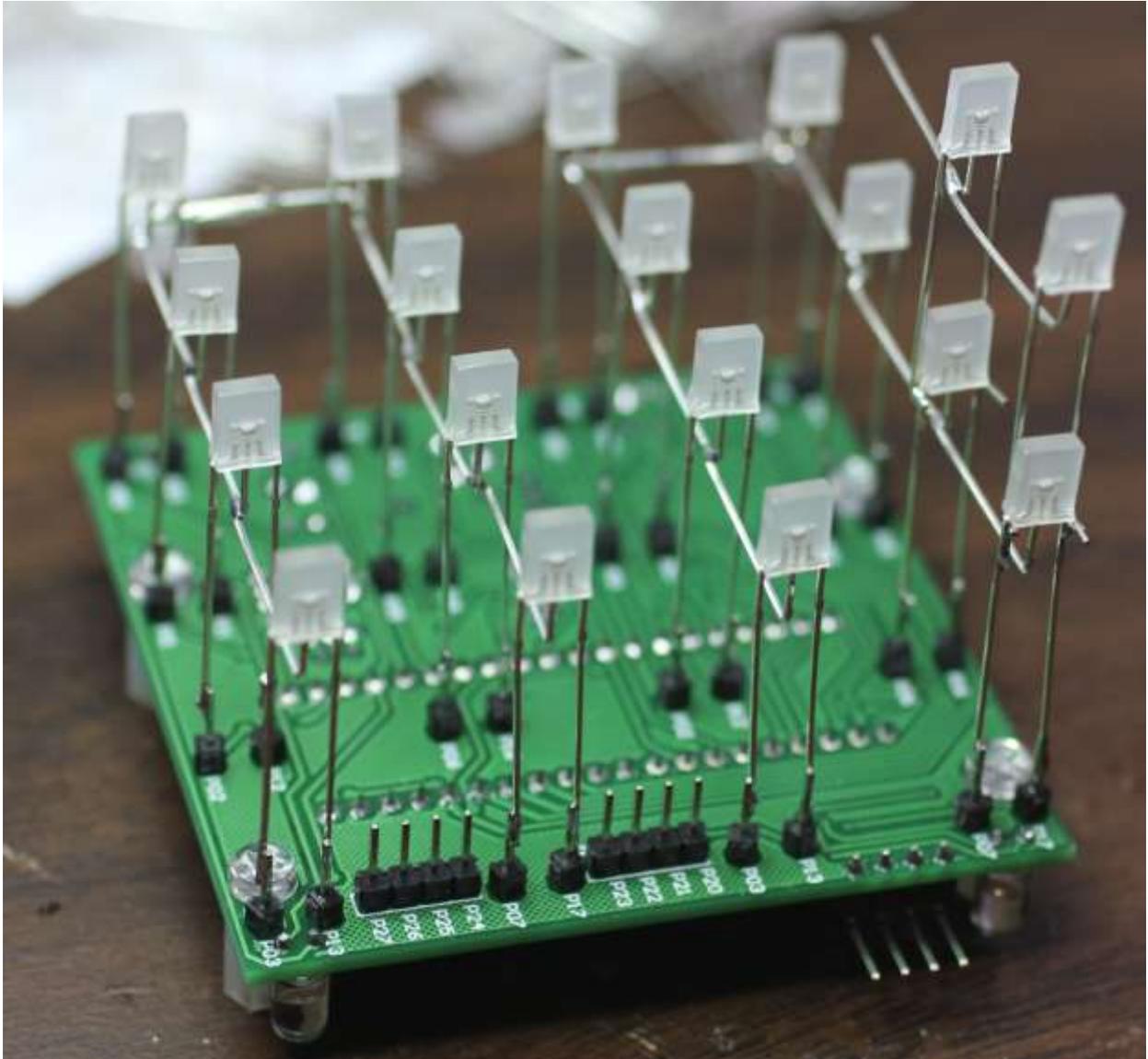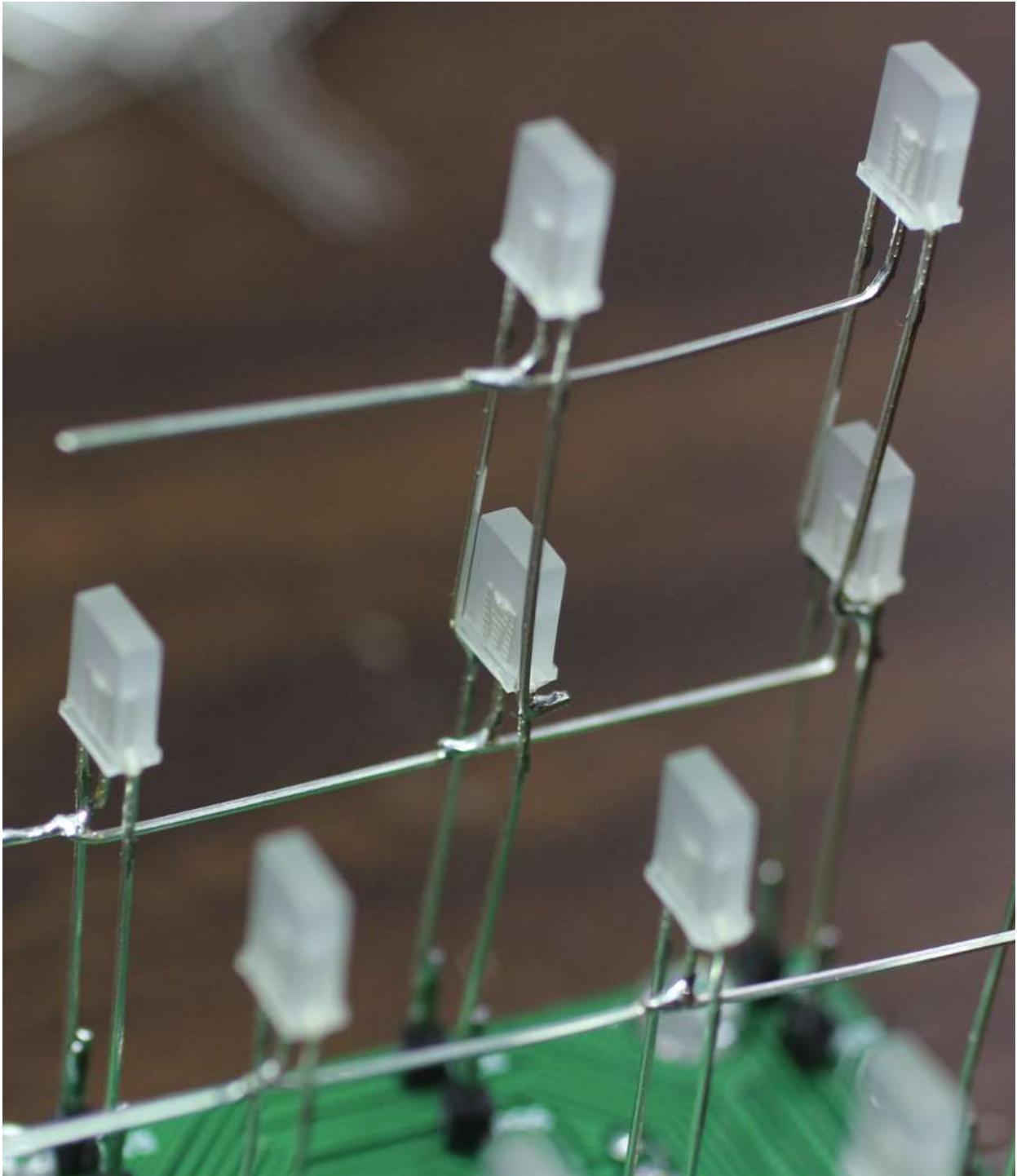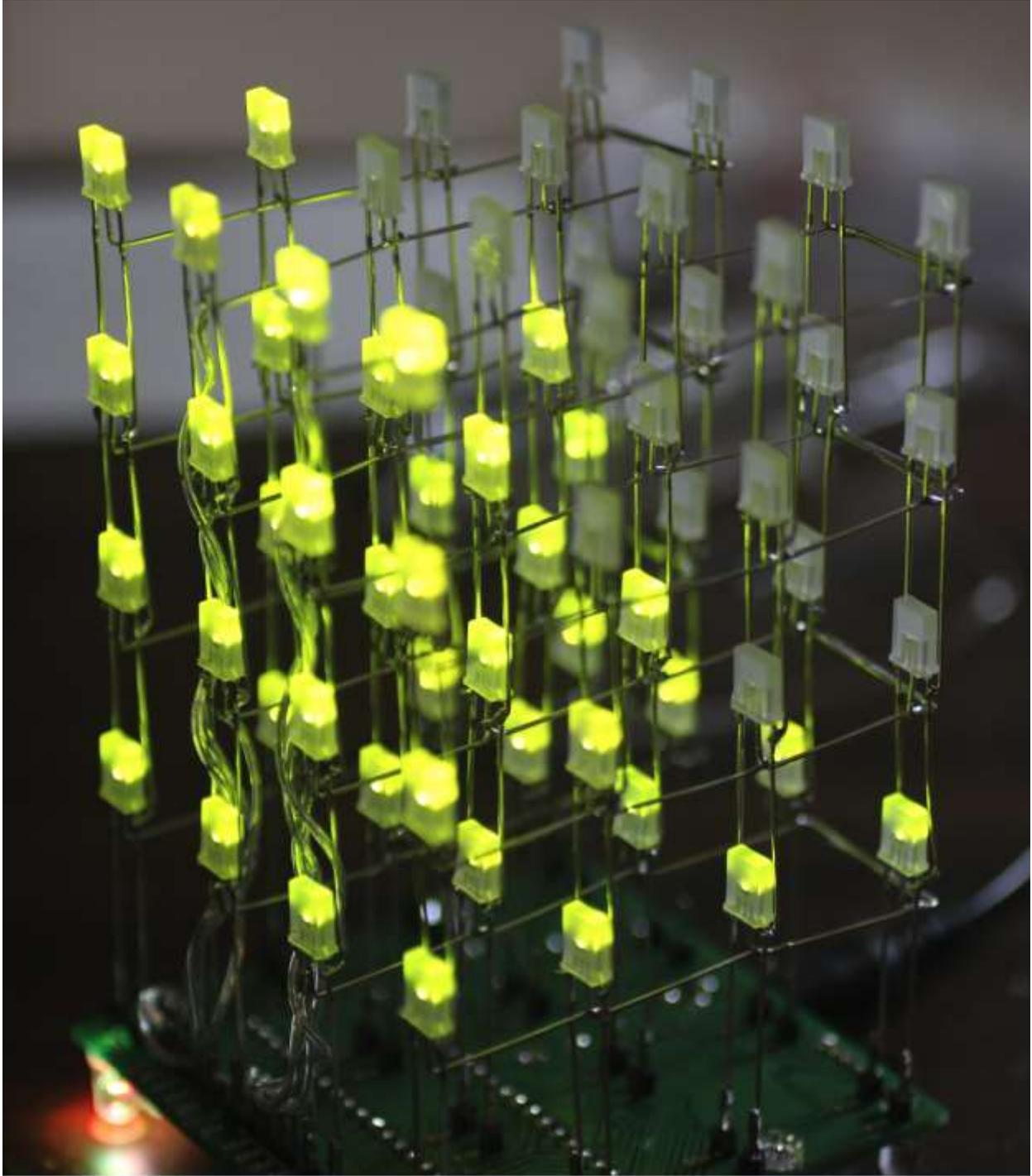
Figure 15 - Beginning of layer 2.

Figure 16 - Daisy chaining center pins.

Figure 17 - Completed Cube